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National PDES Testbed Report Series

Development Plan

STEP Conformance Testing Service

NATIONAL PDES TESTBED

NIST

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STEP Conformance Testing Service

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Preface

This document describes a plan to develop a Conformance Testing Service to support current product data standardization efforts. The Conformance Testing Service is an integral part of an overall strategy for the National PDES Testbed at the National Institute of Standards and Technology (NIST). The National PDES Testbed was initiated in 1988 under the sponsorship of the U.S. Department of Defense Computer-aided Acquisition and Logistic Support (CALS) Program. A major goal of the National PDES Testbed is to provide technical leadership in a national effort to implement a complete and useful specification for the exchange of product data. This specification must be designed to meet the needs of American industry and the CALS program.

The National PDES Testbed supports and actively participates in the international effort to develop the Standard for the Exchange of Product Model Data (STEP). The STEP development effort is led by the International Organization for Standardization (ISO) Technical Committee 184 (TC184) Sub-Committee 4 (SC4).

This plan describes one of several technical project threads that have been established for the National PDES Testbed. Other threads address such areas as:

- development of configuration management systems and services,
- development of testing systems to evaluate the proposed standard,
- specification and testing of application protocols,
- construction of a STEP-based manufacturing cell, and
- establishment of the Product Data Exchange Network.

The level of support provided for these technical threads and others will be determined by sponsor needs and a number of different priorities. As such, the development plan contained within this document outlines a reasonable schedule to accomplish the objectives of the thread. Changes in priorities and levels of support may either accelerate or delay the proposed schedule. This plan will be updated periodically to reflect technical changes in the project, current level of effort, and expected continued support.

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Executive Summary

The Standard for the Exchange of Product Model Data (STEP) is an international standard which is being developed to support the product data management requirements of industry. Different developers of STEP-based systems may implement the standard in different ways. These variations could lead to incompatible systems, thus defeating the purpose of the standard. Conformance testing offers a solution to this problem. Conformance tests can be used to determine whether or not a particular implementation of STEP does indeed comply with application protocols for STEP.

This technical thread will promote the establishment of an institutional framework for conformance testing and develop methodologies for conformance testing services operating within the framework. Tools developed for STEP validation activities will provide a foundation for the development of conformance testing systems. Conformance testing systems may be developed by NIST and other organizations for use by conformance testing services. The institutional framework will be implemented at approved conformance testing sites within the Product Data Exchange Network which is being established by NIST under the auspices of the National PDES Testbed.

Conformance testing is the testing of a candidate product for the existence of characteristics that are required by the standard. It helps: (1) assure the product meets the requirements of the standard, (2) clarify the standard itself for implementation, (3) provide a feedback loop to the standards-making bodies for improvements to the standard, and (4) encourage commercial development by providing a baseline for commonality in all products. The implementation of a conformance testing system and an independent conformance testing service increases the likelihood that different STEP implementations will be able to interoperate, i.e., work together.

In the conformance testing process, the Client is the organization or individual seeking assurance that the Client's product complies with the standard. With the successful completion of conformance testing on a Client's STEP implementation, the Client may obtain a certificate of validation. This certificate may provide the Client with a market advantage: (1) it may permit the Client to bid on a government contract or (2) show a potential government user that the Client's product has been tested under a controlled environment by an independent Testing Laboratory. This formal process improves the competitive edge for the Client over those implementors who have not gone through the same process.

The Conformance Testing Service thread of the National PDES Testbed will: (1) promote the construction of conformance testing tools and systems by appropriate organizations and projects, (2) develop test procedures and data that adhere to STEP specifications, (3) specify the process which will be used for validating compliance with the standard, (4) define the procedure which will be used to approve and review the operations of conformance testing sites, and (5) establish a conformance testing service at selected sites

within the Product Data Exchange Network. The National PDES Testbed will work with other outside organizations to promote and accelerate the development of a conformance testing service in order to support the objectives of the DoD Computer-aided Acquisition and Logistic Support (CALS) Program.

The initial focus of the conformance testing service will be to implement conformance tests for a single STEP application protocol. An application protocol defines the context for the use of product data and specifies the use of the standard in that context to satisfy an industrial need. An example of a context for the use of product data is process planning. An application protocol contains an abstract test suite which is an English language definition of a function or capability that is to be tested. The abstract test suite is used to create an executable test suite. The executable test suites are computer instructions written in an appropriate computer language which implement the test definition contained in the abstract test suite. The conformance testing system will use the executable test suite to exercise a Client's product to determine whether the function or capability required by the application protocol has been implemented.

The conformance testing service will be used by implementors, government agencies, and academia to ensure that commercially-developed systems conform to the requirements of the appropriate STEP application protocol(s). This project will work with appropriate organizations (to be determined) in order to define the conformance assessment process. This process will be carried out by an approved Testing Laboratory for a specific Client.

The conformance testing service development effort will be closely coordinated by the National PDES Testbed in conjunction with the International Organization for Standardization's (ISO) STEP standards on conformance testing and international activities currently underway within the European Community. It is critical that the United States aggressively position itself among the leaders in conformance testing of STEP application protocol implementations in order to protect U.S. interests in the product data technology arena.

1 Goals and Objectives

Achieving the goals of product data sharing depends upon conformance testing. It is essential that system implementations can be tested to determine whether they conform to the relevant Standard for the Exchange of Product Model Data (STEP) specifications. Standard test suites should be available for use by: suppliers or implementors (for use in self-testing), users of product data exchange products (for testing vendor's products), or by other third-party testing organizations (for independent testing purposes). The CALS Test Network and the proposed Product Data Exchange Network are potential users of the conformance testing service established by this project.

The National Institute of Standards and Technology (NIST) has historically played an important role in the development of conformance testing services and conformance test suites which are used to determine whether or not information technology products comply with appropriate standards. The Omnibus Trade and Competitiveness Act of 1988 was passed by Congress and signed into law on August 23, 1988. Under this Act, NIST was given the charter ". . . to assist industry in the development of technology and procedures needed to improve quality, to modernize manufacturing processes, to ensure product reliability, manufacturability, functionality, and cost-effectiveness, and to facilitate the more rapid commercialization . . . of products based on new scientific discoveries" [OTCA88]. Conformance testing helps ensure better reliability, functionality, and more rapid commercialization of products.

It is essential that implementation validation services are available worldwide, using procedures which are acceptable to the cooperating countries. Implementation validation is the complete process of accomplishing all conformance testing activities necessary to enable the conformance of an implementation or a system to a standard to be assessed (the conformance assessment process); when the fulfillment by an implementation under test (IUT) of all requirements specified is demonstrated, optionally issuing a certificate [ISO1-90].

The goal of the Conformance Testing Service thread is to develop and demonstrate a conformance testing service which can be used to ensure STEP implementations within DoD comply with accepted application protocol standard(s). Conformance testing methods shall be applied only to implementations of an application protocol. An application protocol defines the context for the use of product data and specifies the use of the standard in that context to satisfy an industrial need [ISO1-90].

To achieve the above goals, the project has the following objectives:

- Promote the development of a conformance testing service within which to operate a conformance testing system for application protocol implementation testing.

- Establish an international definition and acceptance of a common testing methodology, and appropriate test methods and procedures.

- Identify the tools that are required to implement a conformance testing system.

- Demonstrate a successful conformance testing service for a single application protocol.

- Minimize the need for repeated conformance testing of the same system through wide acceptance of conformance test reports produced by different Testing Laboratories.

- Achieve an adequate level of confidence in the executable test suites as a guide to conformance.

- Achieve comparability between the results of the corresponding tests applied in different places at different times.

- Achieve repeatability of results for the same executable test case (ETC) applied against a given implementation.

The development of a conformance testing service will require a significant investment in management and technical staff resources, software, equipment, and facilities. These costs will be compounded by the number of executable test suites required for each application protocol which is needed by the U.S. Department of Defense.

Once such a conformance testing service is established for STEP implementations, it must be made consistent across national boundaries. In the past, strong coordination and cooperation with other countries have proven to be the most economical approach to the development of conformance testing systems and services. This approach has facilitated a more rapid development of conformance testing services for other international standards.

2 Overview of the Conformance Testing Service

Technically sound national and international standards are needed to preserve open competition in international markets and to support increased productivity and delivery of services at reduced cost. Through standards, users are provided with off-the-shelf, compatible hardware, software, and communications products for computer and related telecommunications systems. Implementation validation of these computer products claiming conformance with standards further reduces risks and uncertainties to vendors and users. Uniform conformance testing procedures should be employed to perform this implementation validation for a more consistent comparison of results among products [SJK88].

The most commonly used test method for conformance testing computer software products is falsification testing. Falsification testing is a test method which does not guarantee conformance to a standard but is developed to find errors in the implementation. If errors are found, one can correctly deduce the implementation does not conform to the standard; however, the absence of errors does not necessarily imply the converse. Thus, conformance to a test suite alone does not guarantee interoperability. Conformance testing does give potential buyers of a product the confidence that a certified implementation has the required capabilities and that its behavior conforms consistently [ISO31-90].

2.1 What Needs to be Done?

Steps in developing a conformance testing service are characterized by the following major activities:

- Selecting a STEP application protocol and its supporting abstract test suite.
- Generating an executable test suite using the abstract test suite.
- Extending, if necessary and appropriate, the National PDES Testbed model validation hardware and software system to provide the capabilities for application protocol conformance testing.
- Defining the conformance assessment process carried out by a Testing Laboratory for a given Client.
- Providing a conformance testing service for CALS implementations, other implementors, government agencies, and academia for the chosen application protocol.

2.2 Is Neutrality Important?

A conformance testing service must be unbiased in its evaluation of the conformance of a product to a particular standard. Furthermore, the institutional framework in which a conformance testing service operates must be neutral to ensure that all Clients are treated fairly. The organization, which sets up the conformance testing service, must not have a vested interest in the implementation of any particular vendor.

NIST is an appropriate institution to establish the ground rules, guide the development of a conformance testing system, identify the appropriate Testing Laboratories, and write the procedures for a conformance testing service. NIST has prior experience from various other established conformance testing programs, e.g., the language compiler validation testing program (Pascal, Fortran, ADA), graphics conformance testing programs (GKS, CGM, PHIGS), and the Database Language SQL conformance testing program. Other conformance testing programs still under development have also contributed to NIST's "lessons learned," e.g., GOSIP and POSIX. NIST also participates actively in the national and international STEP conformance testing arenas. The National PDES Testbed at NIST has a vested interest in providing conformance testing services for STEP implementations in support of the DoD CALS Program.

2.3 How Will the National PDES Testbed Establish a Conformance Testing Service?

The National PDES Testbed will provide oversight of the conformance testing service. It will establish appropriate conformance testing policies, procedures, and testing laboratory accreditation requirements. The resources necessary to develop the conformance testing system and staff the Testing Laboratories which conduct the actual conformance testing services will be identified. The basic steps required to develop the service are outlined below (see section 3 for a more detailed discussion):

- Identify the application protocol implementation priority
- Promote the development of conformance testing systems
- Identify and approve candidate Testing Laboratories
- Develop conformance testing procedures and data
- Convey conformance testing systems to laboratory sites

As new application protocols are specified for different product data technology areas, it is likely that new laboratories will be identified. For simplicity, the procedures and discussion outlined below address a single STEP application protocol. The same technical processes of developing executable test suites or evaluating existing executable test suite generators would be repeated for each and every application protocol. The conformance testing service itself and administrative processes of running a conformance testing service would remain constant. The level of investment required to establish a

conformance testing service for a single application protocol, as well as the resources needed for each additional application protocol, is still difficult to assess.

2.4 How Will the Service Operate?

The operation of the conformance testing service is based upon three key organizational elements. These elements will have varying degrees of responsibility throughout the development and the operation of the conformance testing service (see figure 1):

> Client - The organization that submits an implementation for conformance testing [ISO31-90a]. This is normally a company which develops a product for commercial use.
>
> Testing Laboratory - An organization that carries out the conformance assessment process. This can be a third party, a user organization, and an administration [ISO31-90a].
>
> Certification Body - An impartial body, governmental or non-governmental, possessing the necessary competence and reliability to operate a certification system, and in which the interests of all parties concerned with the function of the system are represented [ISO31-90a].

These roles will be carried out as: the Client--normally a system's developer who is a potential or active contractor for DoD; the Testing Laboratory--an approved independent testing site; and the Certification Body--the National PDES Testbed.

The role of the Client is independent of any conformance testing service development. The Client has to progress through the major milestones of implementation development as depicted in figure 1. During the early stages of implementation development, the only interest the Client may have in conformance testing is to obtain and understand the standard abstract test suite (ATS). In later stages of development, the Client may want to acquire a set of executable test data files from the Testing Laboratory for "debugging" his implementation or performing implementation "prevalidation"; otherwise, the Client keeps a low profile in the scheme of the conformance testing system and conformance testing service development process. The Client's role is as a user of the conformance testing service.

Once a conformance testing system is set up and evaluated, the usual proforma is that a conformance testing service will become self-sustaining. Costs associated with such a service are usually carried by the Testing Laboratory and the Client. Typically, the Testing Laboratory must cover the costs associated with setting up the service, getting approval from the Certification Body, and maintaining that approval. The Client must

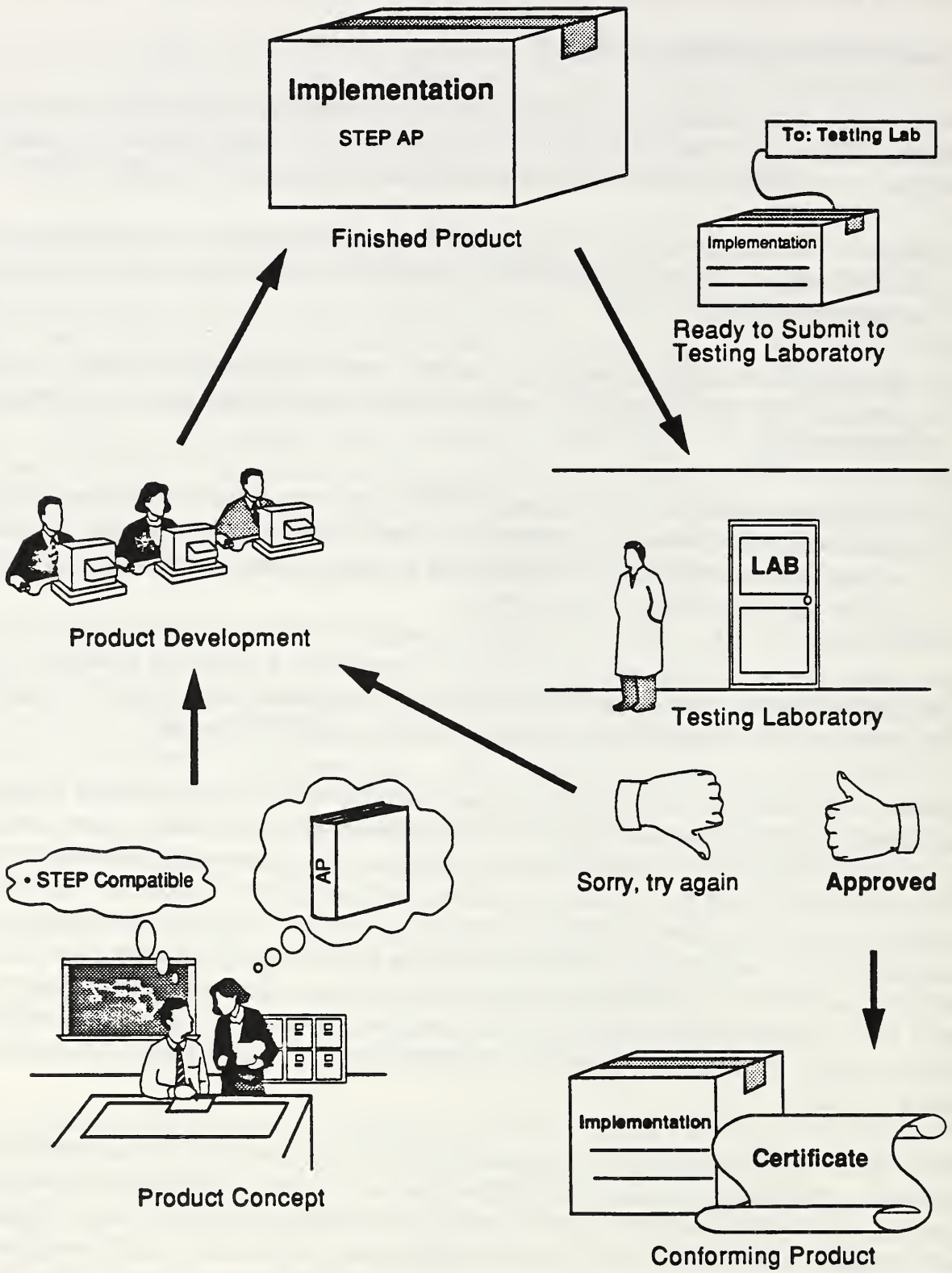

Figure 1. Conformance Testing

cover the costs associated with having his implementation evaluated and a test report generated.

The establishment of a conformance testing service will require the completion of all of the tasks described in section 3 of this document. Once the service is established, the scenario a Client goes through is normally as follows:

1. *Request Conformance Testing* - The Client provides information and supporting materials to the Testing Laboratory in a Letter of Request. This letter would include such information as: product identification, including version; host and target configurations, operating systems, program language and other appropriate system information; a Client representative to contact for conformance testing; and the implementation of a standard application protocol against which the Client is applying for conformance testing (perform prevalidation on the implementation).

2. *Prepare for Testing* - The Client prepares the administrative and more detailed technical description of the implementation which will undergo testing. The Testing Laboratory prepares the site for testing and selects the appropriate abstract and executable test cases. At this time, the Client may also request a set of executable test data files to prepare the implementation prior to actual testing (perform prevalidation on the implementation).

3. *Conduct Testing Operations* - The Testing Laboratory coordinates a suitable date for conformance with the Client. The Testing Laboratory reviews all details associated with the system under test (SUT). The actual executable test suite to be used for the conformance testing is generated. After this point in the process, the Client cannot change the scope of the conformance assessment. The tests are run and the results are recorded.

4. *Analyze Results* - For each executable test case, a verdict of "pass," "fail," or "inconclusive" is established. (Inconclusive will only be used on those rare occasions when neither a clear pass nor fail has resulted.) The Testing Laboratory analysis is performed by comparing the observed test outcomes with the expected test outcomes, and a detailed conformance test report is generated.

5. *Appeal Test Results, If Necessary* - If a Client believes any tests are in error or not appropriate, or is not satisfied with the detailed conformance test report, the Client contacts the Testing Laboratory and provides associated justification for the dispute. It is up to the Testing Laboratory and Client to resolve the dispute. (If the Client is anticipating applying for a Certificate of Conformance, a copy of this letter should be forwarded to the Certification Body as well.) The Testing

Laboratory will publish the test report after the Client agrees to the test report contents.

6. Request Revalidation - When changes are made to the Client's implementation, or when the abstract test suite has been modified, the Client's implementation should be revalidated. Revalidation provides a more up-to-date test report for marketing the capabilities of the implementation.

2.5 What are the Issues Involved?

There are three different types of issues from which the development of a conformance testing system and a conformance testing service have to be examined: technical, administrative, and political. The next three sections address these issue areas.

2.5.1 Technical Issues

STEP contributes to the goal of efficient communication of product data. It supports exchange of data between computer software systems with similar or related functions but dissimilar internal data formats and structures. It provides neutral information reference models and standardized implementation practices for advanced computer software systems to enable the use of STEP as their internal data format(s) in the longer term. In the "data exchange" role, STEP will be implemented in computer system translators and referenced in data delivery agreements. In the second role, STEP will be implemented in the core of computer systems and referenced in system architecture documents for coordination between system components [ISO1-90].

The technical issues are associated with the development of the conformance testing system itself and the supporting executable test suite generator. Initial conformance testing for STEP is targeted at file exchange between two systems. Since so little is currently known on how conformance testing will occur against database implementations, this document will emphasize conformance testing of implementations used for file exchange. As international consensus is reached on how conformance testing will be approached for databases, this document will be updated to reflect those decisions. As commercial implementations are developed for both file exchange and database, the National PDES Testbed will be faced with the issues associated with development and simultaneous support of multiple conformance testing services.

Conformance Testing Process for File Exchange

A conformance testing service for file exchange conformance testing can be handled very similarly to those of other standards, e.g., Computer Graphics Metafile (CGM), [FIP128] where the executable test suite is processed against an output data file from the

preprocessors or postprocessors (generators and interpreters in CGM). A preprocessor is a software unit that translates product information from the internal database format of a certain CAx system to an independent public domain product data format [ISO1-90]. (CAx is used to generically describe any computer-aided system.) Preprocessor analysis is clearer than the postprocessor analysis, since in this case the results are a known form on which to work: a STEP data file. The data files can be checked for syntactical conformance, through a parser, then compared against the expected model as specified by the abstract test suite, as well as for semantical conformance as prescribed by the application protocol.

A postprocessor is a software unit that translates product information from an independent public domain product data format to the internal database format of a certain CAx system [ISO1-90]. There are two options to perform analysis on the results of postprocessor tests:

- Output a STEP file using the preprocessor and use that as the basis for analysis.
- Process the postprocessor against an executable test suite derived from the standard abstract test suite.

The first requires the preprocessor to have been tested and to have relevant support in the context of each postprocessor test. This approach does not address the problem of symmetric errors in the two processors or take into account the situation where there may be only a postprocessor undergoing testing [JO90].

The second analysis method should be adopted whenever possible. Both syntactic and semantic (structure and use in terms of the properly defined standard meaning) evaluation can be performed based on the requirements of STEP and the specific application protocol. The analysis can be highly automated and, therefore, objective. See figure 2 for a simple architecture of the file exchange conformance testing system and conformance testing system capabilities.

Conformance Testing of a Database Implementation

A major goal of the STEP effort is product data sharing through shared databases. Components of a STEP data sharing environment and the issues arising from implementation of such an environment are discussed in "A High-level Architecture for Implementing a PDES/STEP Data Sharing Environment" [PI91]. The key to realize a heterogeneous STEP data sharing environment is establishing a standard software interface between STEP data storage management software systems and applications producing/consuming data (according to specific application protocols). Specifying such an interface is currently underway in the ISO STEP Working Group on Implementation

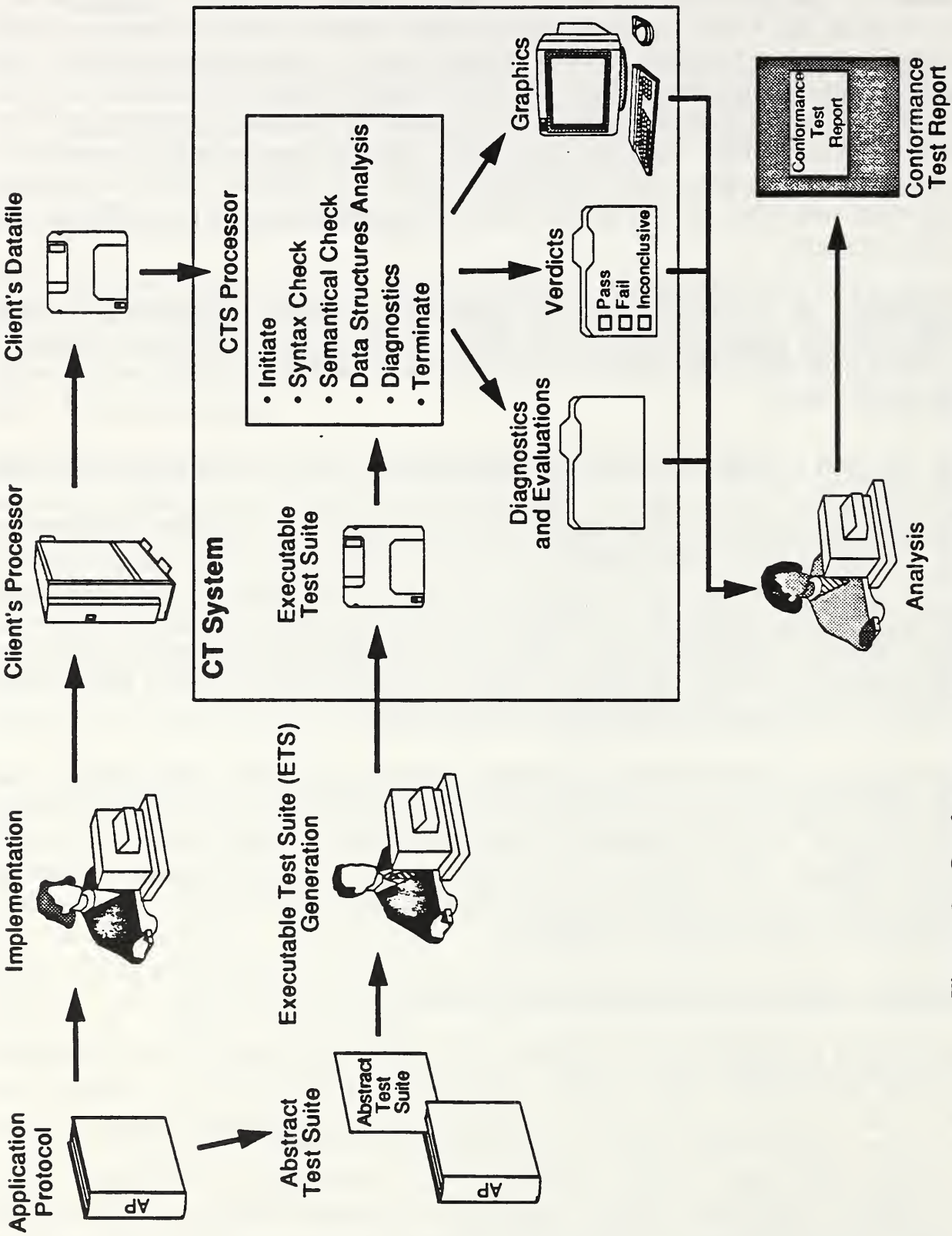

Figure 2. Conformance Testing System Architecture

Specifications [DP91, JF90]. The interface is commonly known as the STEP Data Access Interface (SDAI). When SDAI becomes part of STEP, vendors desiring to provide systems which share data through databases will implement the interface as part of their applications or databases. Applications producing/consuming STEP data will make SDAI requests for STEP data to shared databases and the databases will respond to those requests accordingly. Thus there will be a need for conformance testing of an application's support of SDAI in the context of the application protocol with which it intends to comply. Additionally, there will be a need for conformance testing of a database's ability to provide STEP data according to requests of SDAI by applications.

Since SDAI is a software interface, it will in many respects simplify the task of executing conformance tests against both applications and databases. CT system processors can be written against the SDAI specification rather than against proprietary application interfaces or database vendor's proprietary storage design for STEP data.

2.5.2 Administrative Issues

Procedures are needed which encourage cooperation by national and international certification and standardization bodies to operate under a common strategy. These institutions should mutually recognize conformance testing results and certificates for STEP application protocol implementations. The scope of current cooperative activities in other conformance testing services ranges from the bilateral recognition of the Testing Laboratories (e.g., a Memorandum of Understanding) to the use of internationally standardized testing procedures.

The conformance testing service under which the National PDES Testbed plans to operate will be coordinated with both the International Organization for Standardization (ISO) STEP conformance testing procedural standards and international activities currently underway within the European Community. Such a multi-national conformance testing service agreement already exists for CAD/CAM exchange standards between several European countries [CTS88].

Figure 3 provides an illustration of the relationships between the various authorities involved in a conformance testing service. The Client and Testing Laboratory have been previously introduced; their role within a conformance testing service will be briefly outlined below. Beyond the Client and the Testing Laboratory, additional authorities associated with a conformance testing service are the Certification Body and (optionally) the Accreditation Body.

The members of the Certification Body should be organizationally separate from the Testing Laboratory staff. Certification Body responsibilities include approval of the test method and executable test suite generator, approval of the conformance testing

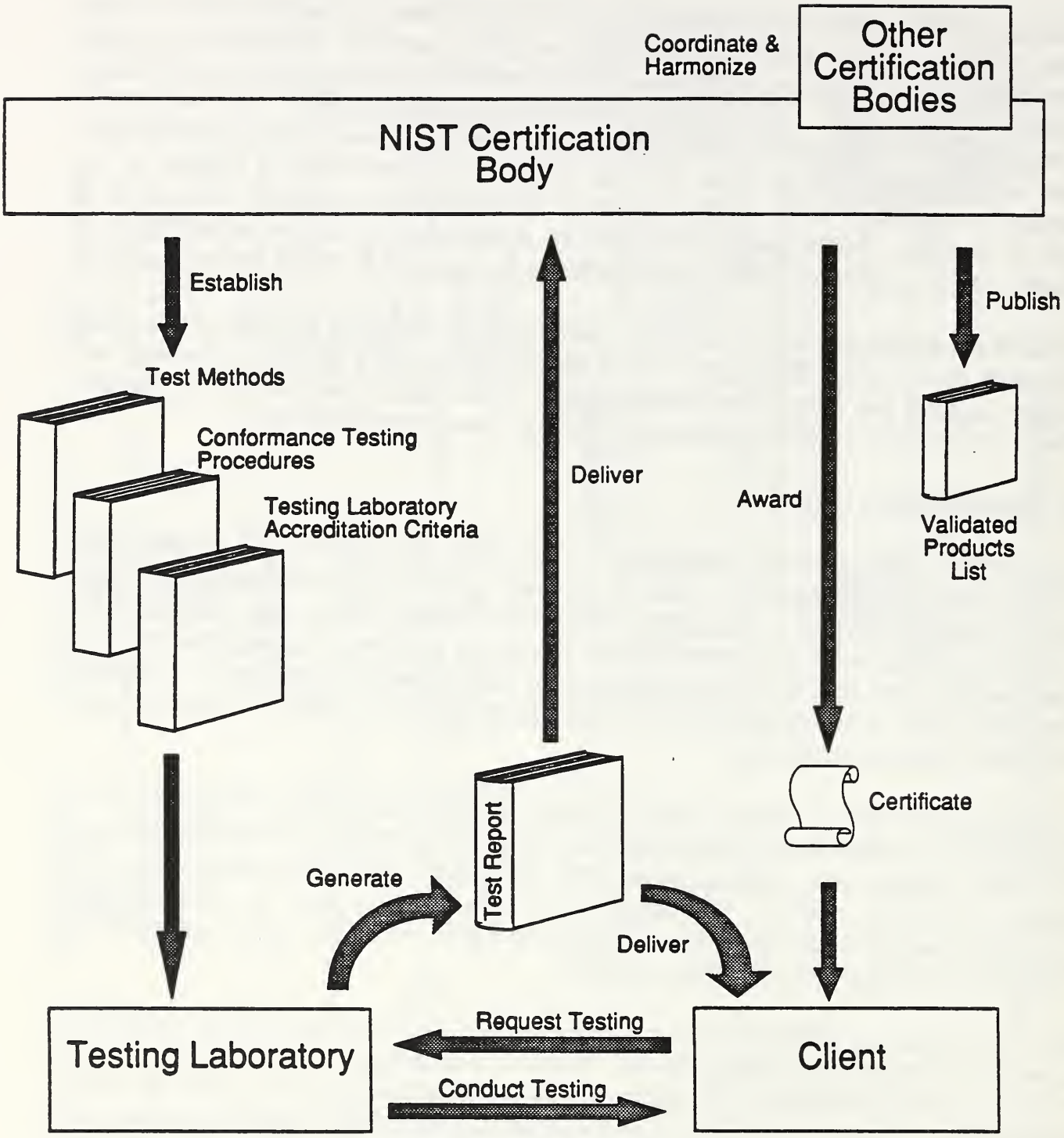

Figure 3. Implementation Validation

procedures, and definition of the criteria for recognizing a Testing Laboratory. Figure 4 shows the various methods for Testing Laboratory selection and recognition.

If economics, conformance testing requirements, and politics warrant accreditation of Testing Laboratories, an Accreditation Body's services would be employed. An Accreditation Body conducts and administers a laboratory accreditation scheme and grants accreditation. This assessment of a Testing Laboratory may be carried out in full or in part by the Certification Body instead. Testing Laboratory accreditation is the formalized initial and continuing process of ensuring a Testing Laboratory is competent to carry out specific types of tests. The term "laboratory accreditation" covers the recognition of both the technical competence and the impartiality of a Testing Laboratory [ISO31-90]. Accreditation is normally awarded following successful laboratory assessment, the steps as shown in figure 4 [SJK88], and is followed up by appropriate surveillance. It is likely that some of the Testing Laboratories associated with the Product Data Exchange Network [SF90] will be interested in seeking acceptance as Testing Laboratories under the STEP conformance testing service.

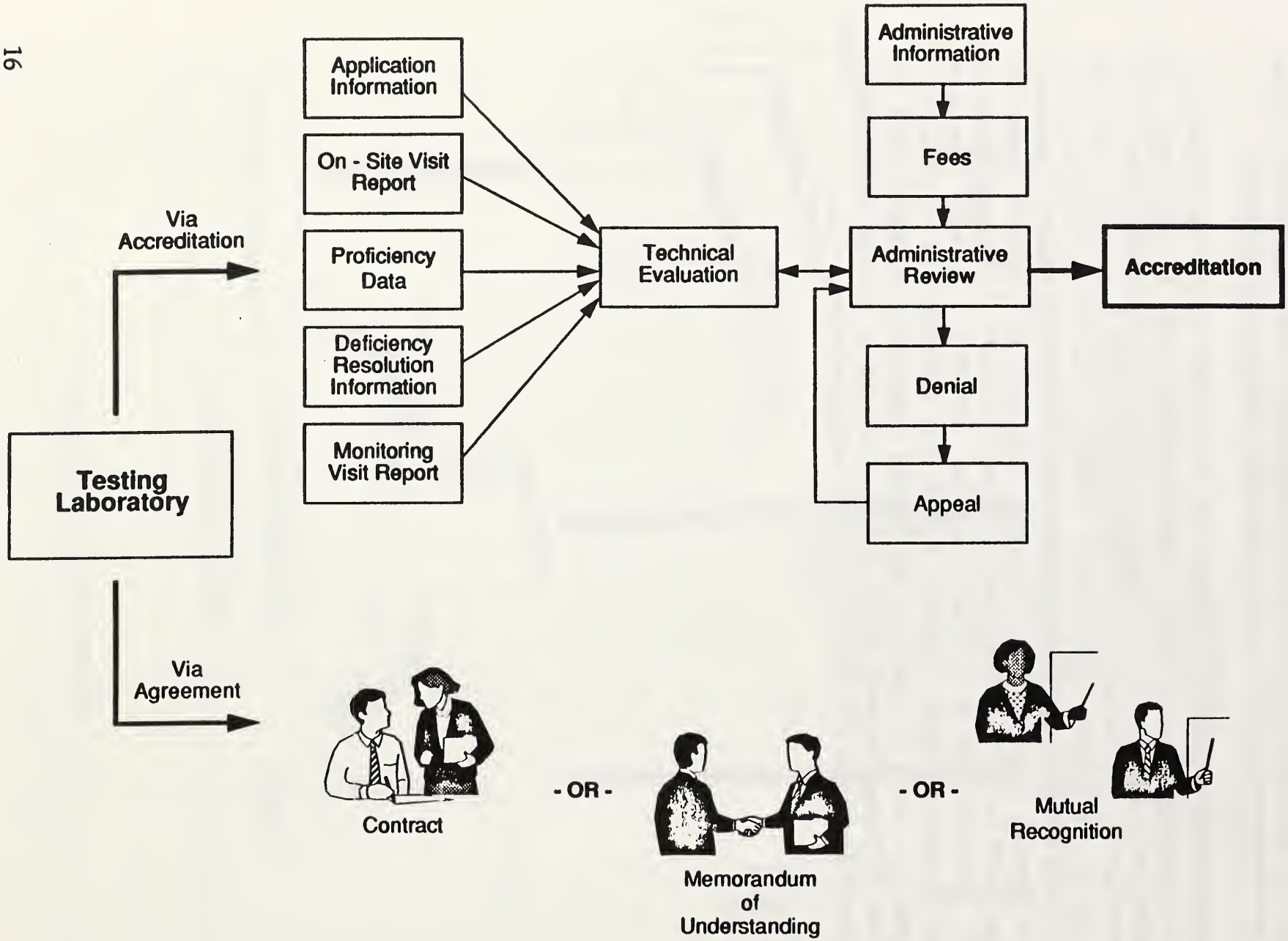

Figure 4. Laboratory Selection

2.5.3 Political Issues

The Commission of the European Communities (CEC) is acting swiftly and deliberately to turn twelve European countries[1] into a single, integrated market of 320 million people by the end of 1992. The basis for this effort is a 1985 European Community (EC) White Paper entitled "Completing the Internal Market." That paper sets a timetable for the measures needed to ensure the free circulation of persons, products, services, and capital among the twelve member states. The EC already initiated a program to eliminate the many differing national standards and technical regulations; it has drawn up more than 200 EC directives aimed at harmonizing the various national requirements.

The task of establishing European technical standards for products will be left to European standardization bodies set up by industry[2] and other European governments. In the absence of standards to be harmonized or cited, the CEN-type (European Committee for Standardization) organizations are to adopt standards based on international standards developed by such groups as the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) [PC88].

In support of the EC economic goal of 1992, the United Kingdom, Germany, and France are collaborating on a common objective for CAD/CAM systems data exchange interfaces: to provide harmonized testing services within Europe for the transfer of product models between different CAD systems using neutral formats. Started in December 1988, this service will be ready for use in time for the approval of ISO STEP and offer interim services for the U.S.-based Initial Graphics Exchange Specification (IGES), the German-based (VDAFS), and the French-based (SET). Both the development of the test tools and the establishment of operational Testing Laboratories offering testing services are covered in the project. Established as a multi-phased project, the current phase is part of a broader program Conformance Testing Services Two, commonly known as CTS2. In addition to the four full nation partners, there is one associate partner, Sweden. Beyond national commitment of resources and money, the EC members are funded by the Commission of the European Community [CTS88][FWK90].

National PDES Testbed staff believe that it is critical to actively participate in this cooperative international effort. As such, a Testbed representative provided a briefing

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[1]The Member States of the EC include Belgium, Denmark, France, Germany (F.R.), Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, and the United Kingdom.

[2]Such as the European Committee for Standardization (CEN) which promotes European regional standardization in the non-electrotechnical field; European Committee for Electrotechnical Standardization (CENELEC); and European Conference of Postal and Telecommunications Administrations (CEPT) which publishes recommendations to harmonize and improve administration and operational services.

paper at the CAD/CAM CTS2 meeting in September 1990 as part of a first attempt to collaborate in the conformance testing service activities. Initially focussing on IGES, NIST has extended its activities through the National PDES Testbed into the STEP conformance testing service program and policy development. Having a nationally-based conformance testing service helps U.S. industry remain competitive at home and abroad. Through NIST collaboration with the EC 1992 conformance testing activities and the establishment of an internationally cooperative conformance testing service, CALS-supported implementations are afforded better opportunity for accepted use and distribution worldwide.

Resolution of the above technical, administrative, and political issues is critical to a successful STEP conformance testing service. As we progress through the standardization and implementation of STEP application protocols, we may identify more issues, as well as realize solutions to those issues stated above.

3 Development Plan

The following tasks need to be accomplished over the time period specified in this plan. In order to accomplish such a rigorous agenda, the National PDES Testbed will be dependent on development activities carried out by private enterprise, industry associations, and the academic community. Other than those efforts associated with CTS1 below, the tasks of this plan apply to a single application protocol.

CTS 0 Prepare Technical Development Plan

This document is the CTS 0 deliverable.

CTS 1 Identify DoD Application Protocol Implementation Priority

Determine what the U.S. DoD priorities are for the various standardized application protocols. Those application protocols from the STEP specification 200 series parts will be examined and should be considered only if they are at the draft international standard level. Commercial product developers are not likely to begin intense development activities until this level of specification is reached, i.e., when the standard is considered more technically stable. It also is more prudent for the conformance testing system tool development efforts to begin only during the later stages of the committee draft cycle of any given application protocol. Steps appropriate for gathering the necessary information include: hold workshops, evaluate AP proposals, and select the first application protocol for conformance testing.

CTS 2 Develop Conformance Testing Procedures

Based on the STEP parts which address conformance testing, develop layout and content requirements of test logs, summary and detailed conformance test report formats, document all responsibilities associated with a Testing Laboratory, and establish appropriate fee structure to make a conformance testing program self-sufficient.

CTS 3 Develop Conformance Testing System

This task and its associated sub-tasks will identify requirements for a conformance testing system in support of an effective conformance testing service, and acquire/develop the appropriate hardware and software to develop the system.

CTS 3.1 Requirements Analysis

Identify requirements and constraints for the conformance testing of STEP application protocols. Given any implications identified, revisit and amend where necessary, the schedule and milestones for developing a conformance testing system and conformance testing procedures.

CTS 3.2 Prepare Conformance Testing System Design

Develop a conformance testing system design plan which specifies the actual hardware and software configuration required to provide useful analysis for a conformance testing service. Such aspects as utility requirements, base band networking, and integration will be considered. Identify existing test tools, executable test suite generators, and documentation.

CTS 3.3 Acquire Supporting Hardware, Software, and Equipment

Based on the design plan, obtain (if necessary) any additional commercial software and hardware through donation, loan, or acquisition. Note: The effort required for this task may be minimized if the National PDES Testbed STEP Validation Testing System configuration can be either used "as is", reconfigured, or used as a basis to provide the major components for the conformance testing system.

CTS 3.4 Acquire an Executable Test Suite Generator for the Application Protocol

It is necessary to be able to generate an executable test suite based on the abstract test suite that supports the application protocol. The deliverable for this task will be an executable test suite generator acquired in one of two ways: by accepting an already existing executable test suite generator developed by another organization or country; or by having the executable test suite generator developed. If the latter is necessary, it is much more labor intensive and expensive; however, the options available will be determined by the U.S. DoD user requirements and prioritization of application protocols.

CTS 3.4.1 Accept Existing Executable Test Suite Generator and Support Tools

Assuming that there is already an existing executable test suite generator, support tools, and documentation, the National PDES Testbed will obtain access to them via contract, loan, or purchase. The National PDES Testbed will evaluate the quality and completeness of the products and arrange licensing agreements for those generators which are proprietary. These activities would be closely monitored and coordinated through the other international efforts to ensure that U.S. decisions would be supported worldwide. The conclusion of this task will be that the accepted generator and all support tools are up and running on the conformance testing system. Any necessary debugging after beta testing will be completed. At a minimum, the license agreement shall allow the National PDES Testbed to obtain the generator and make it available to any interested party. There shall be no national restrictions on its use, and an appropriate fee structure for reimbursement to the generator owner shall be developed.

CTS 3.4.2 Develop an Executable Test Suite Generator and Support Tools

Deliverables associated with the development of the executable test suite generator based on the appropriate STEP abstract test suite include: an automated executable test suite generator, Express parser, written specifications for source code development, developed source code, and supporting documentation. This task will be completed only after the executable test suite generator has been completely tested and released for use.

CTS 3.5 Distribute Test Suite Generator

The National PDES Testbed shall announce the executable test suite generator's availability. Included in the announcement shall be: NIST point of contact, how to obtain the test suite generator and support tools, and how to obtain an information package for more details. Deliverables from this task will include: an information package which describes the generator and conformance testing service, fees, and source of availability. Anticipated users of the generator would include commercial vendors, industry, government, and academia.

CTS 4 Identify Testing Laboratory Candidates

Notify institutions which might have an interest in becoming conformance Testing Laboratories. Develop an information package for candidate laboratories which outlines costs and benefits. As an option, accredit candidate laboratories.

CTS 4.1 Determine Appropriate Method of Laboratory Selection

Develop a report which outlines the technical, managerial and administrative requirements necessary for becoming a Testing Laboratory.

CTS 4.2 Accredit Testing Laboratory (Optional)

Develop criteria to evaluate Testing Laboratory qualifications. Advertise for applicants and perform assessment(s). An evaluation report is written at the end of each review, and a presentation is given to the laboratory's management. When a laboratory is approved and it accepts the task, the National PDES Testbed will publish an announcement stating the availability of the accredited Testing Laboratory.

CTS 5 Convey Conformance Testing System to Multiple Sites

Once the conformance testing system has demonstrated prototype conformance testing of the selected application protocol, qualified Testing Laboratory(ies) have been identified, and the policies and procedures for a conformance testing service are

established, the National PDES Testbed will assist in the conveyance of the conformance testing system technology to the identified Testing Laboratory sites. This task will include the sharing of all software specification manuals, government-owned testing tools, procedure manuals; and arranging site licensing for those products used within the conformance testing service which are proprietary.

CTS 6 Provide an Implementation Validation Service

Implementation validation is the complete process of accomplishing all conformance testing activities necessary to enable the conformance of an IUT to a standard to be assessed. Such a service may end either at the issuing of a conformance testing report, or if deemed appropriate and the IUT has met all the requirements, issuing a certificate. Such a validation service will be based on STEP ISO CD 10303-31, "Conformance Testing Methodology and Framework: General Concepts."[ISO31-90a] This task will include writing the policy and procedures for a conformance testing service; developing an appropriate fee structure for the service; advertising availability, and beginning a service.

Figure 5 provides a work breakdown structure for the above tasks. Figure 6 is a Gantt chart which graphically depicts the schedule for this plan. Figure 7 is a table of deliverables associated with the tasks which have been identified.

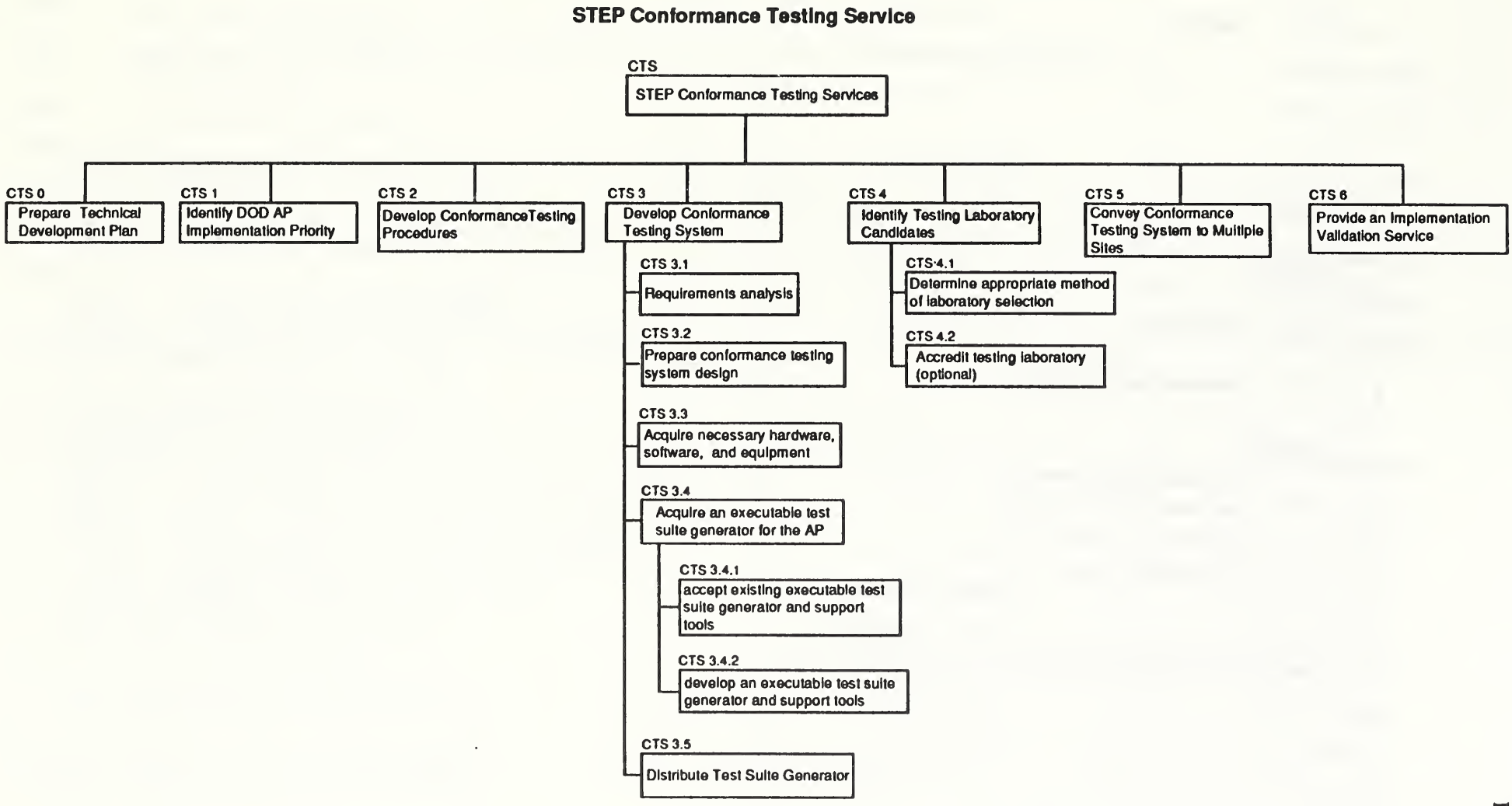

Figure 5. Work Breakdown Structure for Conformance Testing Service Project

Conformance Testing Service

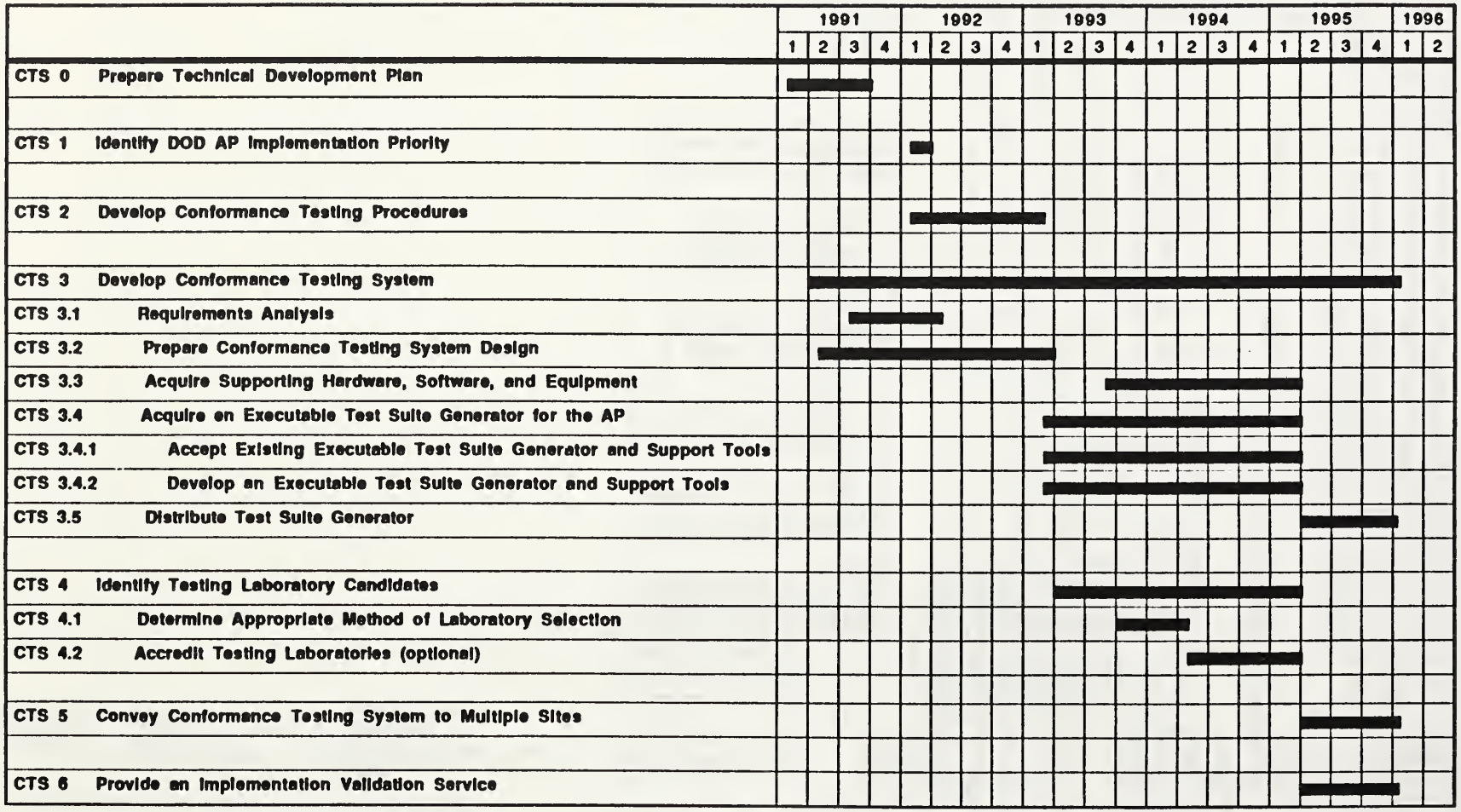

Figure 6. Schedule for the Conformance Testing Service Project

	TASK	QTR START	QTR STOP	DELIVERABLE	SUPPLIER	CUSTOMER
CTS 0	Prepare Technical Development Plan	2/91	3/91	CTS Development Plan	NPT	CALS, DoD, Industry
CTS 1	Identify DoD/Industry Application Protocol Implementation Priority	2/92	3/92	AP Selected	NPT	CALS, DoD, Industry
CTS 2	Develop Conformance Testing Procedures	2/92	2/93	Conformance Testing	NPT	CALS, DoD, Industry
CTS 3	Develop Conformance Testing System	4/91	4/95			
CTS 3.1	Requirements Analysis	4/91	4/92	Summary Report	NPT, *	CALS, DoD, Industry
CTS 3.2	Prepare Conformance Testing System Design	3/92	3/93	System Design Document	NPT, *	CALS, DoD, Industry
CTS 3.3	Acquire Necessary Hardware, Software, and Equipment	3/93	3/95	Conformance Testing System	NPT	CALS, DoD, Industry
CTS 3.4	Acquire an Executable Test Suite Generator for the Application Protocol	3/93	3/95			
CTS 3.4.1	Accept Existing Executable Test Suite Generator and Support Tools	3/93	3/94	ETS Generator	NPT	CALS, DoD, Industry
CTS 3.4.2	Develop an Executable Test Suite Generator and Support Tools	3/93	3/95	ETS Generator	*	CALS, DoD, Industry
CTS 3.5	Use and Distribute Test Suite Generator	4/95	ongoing	Information Package	NPT	CALS, DoD, Industry
CTS 4	Identify Testing Laboratory Candidates	4/93	3/95			
CTS 4.1	Determine Appropriate Method of Laboratory Selection	4/93	4/94	Selection Methodology Document	NPT	CALS, DoD, Industry
CTS 4.2	Accredit Testing Laboratory (Optional)	4/94	3/95	Accredited Testing Laboratory	NIST	CALS, DoD, Industry
CTS 5	Convey Conformance Testing System to Multiple Sites	4/95	ongoing	Established Sites	NPT	CALS, DoD, Industry
CTS 6	Provide an Implementation Validation Service (Optional)	4/95	ongoing	Validation Program	NPT	CALS, DoD, Industry

* Contracted supplier and funding requirements to be determined later.

Figure 7. CTS Project Deliverables

4 Resources

4.1 Personnel

Project Manager. Responsible for developing work plans, defining tasks, and monitoring milestones and activities. Identifies appropriate resources for completing each task. Coordinates activities between the Testing Laboratory, Client and Certification Body. In the absence of a Certification Body, ensuring publication of resultant conformance test reports. Serves as test site coordinator on a continual basis.

Lead Analyst. Responsible for analyzing functional requirements of the abstract test suite. Translates these functional requirements into system design specifications and an executable test suite generator for the conformance testing system.

Software Engineer and Programmer(s). Responsible for developing software utilities in the appropriate programming languages and database languages for the use of conformance testing implementations of STEP application protocols.

Lawyer. Review and approve all written contractual arrangements, memoranda of understanding, and publication arrangements for conformance test reports. Review and approve the certificate format.

Testing Site Coordinator. Responsible for the administrative and budgetary details of running a conformance testing service Testing Laboratory. Publishes announcements for availability of the application protocol executable test suite generator, the conformance testing service, and the validated products list (which lists those implementations which have undergone conformance testing).

Software Evaluator. Responsible for evaluating and assessing the completeness and accuracy of existing executable test suite generator and support tools for their application in this conformance testing service.

Certification Body (optional). Responsible for establishing the certification aspects of a conformance testing service. Manages and coordinates the activities of the conformance testing service. Approves the test method and associated executable test suite generator for the application protocol. Identifies the Testing Laboratory(ies) capable of performing a conformance testing service. Establishes the conformance testing service procedures, and encourages collaboration with other foreign national conformance testing services. Has signature authority on any certificates.

4.2 Equipment

The conformance testing service project will require access to computer hardware and software which will support the operation and evaluation of conformance testing systems.

Computer Hardware

- 3-4 workstations
- personal computers
- local, wide area, and inter-site networks
- laser printers

Software

- file and data editors
- report generators
- commercial database management tools
- parsers
- executable test data files
- executable test suite generator
- commercial graphics display packages

Given the leading activities and required acquisition of hardware and software for the Validation Testing System [MM90], no additional equipment requirements to those listed above are anticipated for the Conformance Testing System.

4.3 Facilities

National PDES Testbed Facility

The National PDES Testbed will serve as the headquarters facility for the conformance testing service.

Product Data Exchange Network Facilities

The Product Data Exchange Network facilities will participate in a variety of ways during the development and implementation of a conformance testing service. Some of this participation may include: executable test suite generator development or evaluation, conformance testing system development, hosting workshops, preparing educational seminars.

Testing Laboratory(ies)

Approved Testing Laboratories will carry out the actual conformance testing and generate test reports against a Client's product.

NIST Conference Room Facilities

Conferences, workshops, and training seminars will require access to NIST conference room facilities.

5 Acknowledgements

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7 Glossary

The following terms, definitions, and acronyms are taken from working drafts of the ISO TC184/SC4 community [ISO1-90], [ISO31-90a].

Abstract Test Case (ATC)
: One or more files, encapsulating the test purpose, which provide the basis from which parameterized executable test cases are derived.

AP
: Application Protocol

CAx
: Any product-related computer-aided software system

CGM
: Computer Graphics Metafile

CTS
: Conformance Testing Service

Conformance Assessment Process
: The complete process of accomplishing all conformance testing activities necessary to determine the conformance of an implementation to an application protocol.

Conforming Implementation
: An implementation under test which satisfies the conformance requirements, consistent with the capabilities stated in the protocol implementation conformance statement.

Conformity
: The fulfillment by an implementation under test of all requirements specified. Also known as conformance.

Executable Test Case (ETC)
: A realization of an abstract test case.

GKS
: Graphic Kernel System

GOSIP
: Government Open Systems Interconnection Profile

Implementation Under Test (IUT)
That part of a product which is to be studied under testing, which should be an implementation of one or more characteristics of the standard.

PDES
Product Data Exchange using STEP

PHIGS
Programmer's Hierarchical Interactive Graphics System

POSIX
Portable Operating System Interface for Computer Environments

Semantics
The relationships of characters or groups of characters to their meanings.

STEP
STandard for the Exchange of Product model data

Syntax
The relationship among characters or groups of characters, independent of their meanings or the manner of their interpretation and use.

System Under Test (SUT)
The computer hardware, software and communication network required to support the implementation under test.

[Abstract (ATS) or Executable (ETS)] Test Suite
A complete set of test cases, possibly combined into nested test groups, that is necessary to perform conformance testing for a standard or group of standards. Note: This term is deprecated unless prefixed by abstract or executable.

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11. ABSTRACT (A 200-WORD OR LESS FACTUAL SUMMARY OF MOST SIGNIFICANT INFORMATION. IF DOCUMENT INCLUDES A SIGNIFICANT BIBLIOGRAPHY OR LITERATURE SURVEY, MENTION IT HERE.)

This document describes a plan to develop a Conformance Testing Service for STEP. The Conformance Testing Service is an integral part of an overall project, the National PDES Testbed at the National Institute of Standards and Technology (NIST). The National PDES Testbed was initiated in 1988 under the sponsorship of the U.S. Department of Defense Computer-aided Acquisition and Logistic Support (CALS) Program. A major goal of the National PDES Testbed is to provide technical leadership in a national effort to implement a complete and useful standard for the exchange of product data. This standard must be designed to meet the needs of American industry and the CALS Program.

12. KEY WORDS (6 TO 12 ENTRIES; ALPHABETICAL ORDER; CAPITALIZE ONLY PROPER NAMES; AND SEPARATE KEY WORDS BY SEMICOLONS)

CALS; conformance testing; National PDES Testbed; PDES; STEP; STEP Application Protocols.

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